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overflowing. He did not deny that Indian wheat would for many years remain a substantial item in the annual wheat imports, but there was no indication that the amount of it would increase at any thing like an alarming rate. With the extension of railways, new wheat-growing districts would be tapped, but the supply of easily available land was by no means unlimited, and the drawbacks and disadvantages were far more numerous than most people supposed. He then commented upon the likelihood of the yield decreasing and the quality degenerating by too frequent growth on the same land. He believed that the land was not seriously impoverished by the native systems of rotation, or by the practice which they had of growing mixed crops; but it would be strange if they altered those time-honored practices, and grew wheat year after year with successful results, as if the land were in the condition of virgin soil. It had been the history of every great wheat-growing region that the yield and quality came down if the land was not kept up by manuring, as in England. He cited America as a typical example. The point where the best wheat grew had steadily marched westward, and he claimed that it had left as a record of its course the ruins of disused and deserted mills. It is not perfectly clear wherein he has evidence of this. Sir Donald Mackenzie Wallace, the author of 'Russia,' and now private secretary to the viceroy of India, related an excellent illustration of the case in point. A district in southern Russia was suddenly stricken with the wheat-growing mania. For a few years the yield, for size of grain, quality, and quantity, was simply marvellous; in a few more years the excess in every way became normal; and in yet a few more years, the produce diminishing in every respect, it became impossible for wheat-growing to continue, and the people had to go back to their rye-crops and other coarser grains. He dealt with the character of the wheats grown in India, and commented upon their inferiority in several respects.

Sir James Caird, in thanking Professor Wallace for his interesting lecture, said that he thought Mr. Wallace had not given as much credit as they deserved to the various agricultural departments in India for their exertions. But in a country so populous, and with an agricultural practice to a certain extent established by a long line of experience of climate and soil, the cultivators have not been slow to avail themselves of the extending facilities of transport, which, in regard to cost on the great railway-lines in India, are now brought very much on a par with the charges in America. An increasing demand, caused by facility of transport, has stimulated production, and has shown that instruction in the art of agriculture is not so much required as access to good markets. India has a great variety of products, and though wheat interests British agriculturists more than any other, cotton stands highest on the list of exports, next to it opium, then oil-seeds, then rice, and fifth wheat. But wheat had, no doubt, gained the most increase of any. The rapid extension of exports of native produce from India in the last ten years is, indeed, very remarkable. The total value in 1877 was sixty-five millions sterling, and in 1886 eighty-five millions, — an increase of nearly thirty per cent. There could be no great deficiency in the knowledge of the cultivators where such a result was possible; and probably the best aid that the government of India could give to native agriculture would be to proceed steadily with the construction of railways in all the richer parts of that vast country which are still without them. With regard to a continued supply of wheat to Europe, he agreed with Professor Wallace that there is neither the same facility for its increased production as in America, nor the same likelihood of a surplus. The population of India and the native states at the last census was two hundred and fifty millions. It is believed to be increasing at a rate which, in ten years, might add twenty million more mouths to be fed. This increase must be provided for, and the periodical return of famines must not be forgotten. We are within a short period of the time when one will be due. He did not, therefore, think that Europe could depend on India so much as America for future supplies of wheat.

HEALTH MATTERS.

Quarantine Systems.

THE quarantine systems of the United States were fully discussed at the Memphis meeting. For years that of New York has been

regarded as the best which could be found along either coast, and its methods have been copied by the quarantine officers of other ports. The condition, however, in which the quarantine arrangements were found to be, when the 'Alesia' and 'Britannia' arrived last fall with cholera on board, has done much to destroy the confidence which up to this time had been reposed in the New York system. For the defects which then existed, and many of which doubtless still exist, the responsibility has not yet been determined. The health-officer places it upon the governor of the State, inasmuch as he has vetoed appropriations which were needed to put the hospital islands and appliances in fit condition to receive immigrants suffering from epidemic disease. On the other hand, it has been attempted to throw the blame on the health-officer himself for not supplying what was needed at his own expense. This latter criticism is unjust. He is not called upon, either as a matter of obligation or duty, to expend the amounts necessary to remedy the defects, and certainly there is no precedent for it either at the port of New York or elsewhere.

During nearly fifteen years of active connection with health organizations, the writer can recall but one instance in which a sanitary official paid out of his own pocket the amounts necessary to prosecute sanitary work, when the authorities failed or refused to appropriate public funds for that purpose. That official was Dr. Davenport of Boston, chemist and milk-inspector of the board of health. The amount expended was, if we remember correctly, more than three thousand dollars, and the last we heard he had not been repaid. If there are other instances, we should be glad to put them on record.

The Philadelphia committee reflected very severely on the management of the quarantine authorities at New York, and their complaints have not been fully met. It appears, however, that cholera has not spread from the hospital islands, and it is to be hoped that the measures taken to extinguish it have been successful. The systems at Baltimore and Philadelphia have been condemned as entirely inadequate to the task of coping with epidemic disease should it make its entrance at either of these ports. These defects were the foundation for the request, made especially by Western sanitarians, that a national quarantine system should be organized, whose restrictions should be similar at all the ports of the United States, thus leaving no port unprotected, but keeping such a vigilant watch over all, that cholera and yellow-fever might with certainty be excluded.

The quarantine system of Louisiana has been brought to such a state of perfection by Dr. Joseph Holt, president of the State Board of Health, that it is now looked upon as the best in the United States. A description of this system was given by Dr. Holt at the Memphis meeting, and is a part of the report of the committee on disinfectants. In this description the writer says there are three maritime approaches to New Orleans, — the Mississippi River, the Rigolets, and the Atchafalaya River. The two latter are closed against all vessels from quarantined ports, compelling such to use the Mississippi as the only available route to New Orleans. The quarantine is a system composed of three stations, the first of which is an advance-guard inspection station situated at Port Eads, one hundred and ten miles below New Orleans. Here vessels are boarded by the medical officer, who inquires as to their sanitary record and present condition. If from a non-quarantined port, and all is well, they go to the city. If a vessel comes from a quarantined port, but gives no evidence of present or past sickness among passengers or crew, she proceeds to the upper station, seventy miles below the city, where she is subjected to sanitary treatment. If, on the other hand, the vessel gives evidence of being infected, she is sent to the lower station, located on Pass à l'Outre, one hundred and three miles below New Orleans. The sick are at once removed to a hospital. The vessel, with the well on board, is thoroughly disinfected by the aid of the quarantine tugboat. The atmosphere below decks is completely replaced with one heavily charged with sulphurous oxide, and wherever possible a solution of bichloride of mercury is applied to effect thorough disinfection.

In speaking of this treatment, Dr. Holt says, "A ship known to be infected with one of the three great pestilential diseases — small-pox, cholera, or yellow-fever — can stand and must endure extraordinary treatment, even if clothing is wetted and some articles

damaged. 'They who go down to the sea in ships' assume the perils of the voyage, among which is this occurrence of finding themselves on an infected vessel, and being compelled to undergo a cleansing; for they have no right to bring their perils ashore and endanger others." The ship, with those on board, is held ten days for observation, and then allowed to proceed to the upper station, where she undergoes further treatment, and then goes to the city.

The methods practised by Dr. Holt are very thorough, and in their application, a tugboat, fitted up with all the necessary machinery, is employed. The bedding of the vessel, together with cushions, mattresses, carpets, rugs, etc., is removed from the ship to a commodious building in close proximity to the disinfecting wharf, where they are treated by moist heat at a temperature of not less than 230° F. During this process of steaming, every article is perceived to be saturated and intensely hot, the steam freely penetrating to the interior of mattresses, double blankets, etc.; but so great is the heat in the texture of the fabrics as to immediately expel all moisture upon drawing the racks and exposure to the open air. Shirts and collars instantly assume the crisp dryness they possessed before exposure, losing the musty smell of long packing in a trunk. Silks, laces, and the most delicate woollen goods show no signs of injury whatever from the treatment. Articles of leather, rubber, and whalebone would be injured by the heat, and are therefore disinfected with the bichloride-of-mercury solution. The time required to charge the chamber with apparel for disinfection is thirty minutes; time required for action of moist heat, twenty minutes; for removal of articles, fifteen minutes,—a total of sixty-five minutes.

The report of Dr. Holt is amply illustrated with figures of the apparatus used in disinfection, and the method of its application, and should be in the possession of every sanitarian as furnishing a model which can be adapted to the requirements of every quarantine station.

MENTAL SCIENCE.

Ideas of Number in Animals.

THE study of comparative psychology labors under two difficulties: the facts upon which it is to build cannot be accurately ascertained without great difficulty; and the interpretation of the facts is a still more delicate and laborious task. Civilized man has looked upon the facts of nature with so entirely a modern mind, that it is a rare gift to be able to appreciate the elementary thought-processes of uncivilized communities or of animals. Every attempt at improving the methods of presenting these phenomena should be received with sympathetic consideration, without regarding as final what is probably only a step to something better. Mme. Clemence Royer has recently made a study of the mathematical powers of animals that deserves the consideration of all students of psychology.

Among men we find all grades of mathematical ability, from that of a Newton and Laplace to that of one who cannot conceive the abstract notion of number. What the savage lacks is not the knowledge of the difference between three men and ten men, but the power to abstract the notion 'three' from men, trees, hands, and so on. The first step in this process is the distinction of unity from plurality, then of duality, etc., from plurality. The relic of this appears in the prevalence of the dual number in rudimentary languages.

What impresses itself upon the primitive mind is the sensory images of objects: he knows the difference between four trees arranged in a quadrilateral and in a row, between the general look of three trees and of four trees, but cannot see any thing in common between four trees and four stones. He is a poor arithmetician, but a good geometer; he is impressed by space relations, not by numerical characteristics. He can judge of distance, of the outlines, of the sizes of objects, but all by an instinctive visual talent. If, then, arithmetical notions appear late in human development, we can hardly expect it to be prominent among animals, lacking an intellectual language. What we can speak of as the language of animals is limited to the expression of the emotions. Their mathematical distinctions are sensory in nature. They distinguish between unity and plurality of certain objects, but we cannot credit

them with abstract notions of 'one' and 'two.' They have a kaleidoscopic, photographic memory, not an abstract verbal one. All the wonderful powers of animals finding their way, of regularity in time, must be accounted for by an accuracy in the perception of outlines, and the unconscious registration of general intervals by feelings of fatigue, number of steps, and so on.

There is no unit of distance or time. Distance is to them a perception, not an idea. Just so a dog, in attacking a boar, accurately judges the length of his leap, the size and strength of the enemy; but this does not involve any mathematical calculations. The apparent understanding of language by trained dogs comes under the same head. The dog does not appreciate the phonetic value of the words, but takes his clue from the intonation, the little gestures, and the like. The horse understands the 'language of the bit' better than that of his master. Animals, in brief, have their geometrical sense of relations well developed (better than men in some respects), but are not arithmeticians.

They do not, however, lack all appreciation of number. They do distinguish between numbers, for this is necessary to their existence; but their distinction, when it goes above a few simple units, is in the form of a bunch-estimate, depending as much on the arrangement of the group as on its size. They cannot estimate as we do when we divide an army into regiments, into companies, and so on, and thus estimate the number of men.

Birds, it is true, are much alarmed if an egg be removed from their nests, but they are equally alarmed if the arrangement of the eggs be disturbed; thus indicating that it is the general disturbance that causes the alarm, not a counting of the eggs. The mother recognizes her young individually, and thus can notice the absence of one; but she probably sees no more difference between the eggs than we do, and judges their number only by their arrangement. Cats probably distinguish their young by differences in the fur, and so on: they are little affected if one kitten be removed; but, if more than four be taken away, they are greatly disturbed, and especially so if but one be left. If the kittens are weaned, the loss is not taken so seriously.

Dogs notice the absence of one of their number; but that they recognize each other individually is shown by their preferences and jealousies, both among themselves and towards men. Shepherds' dogs do not count their fold, but simply have a general picture of its size. Likewise trained dogs do not count, but have simply learned to associate mechanically certain geometrical forms with certain actions. Sir John Lubbock's dog, that brings a different label according as it wants something to eat, to go out, and so on, does not appreciate the intellectual value of the letters, but regards the label as an artificial means for gaining certain ends. The dog's faculties in these respects, however, seem to be not inferior to those of the Bushmen, who count only to two, and call all above that 'many.' Number is here concrete only with reference to objects where plurality is a useful trait: it is never abstract, and so can no more reach the stage of mathematical art than can their emotional language reach the stage of ideational abstraction to which ours has attained. By this is not meant that animals can form no abstract notions, but that their general notions are very limited in scope, and are along the line of directly useful interests only. The animal thinks by generic images, does not err in its judgments, is not liable to fallacies, all of which are distinctly human because we think by the intervention of words; and this difference forms the difficulty of our communication with them.

Animal-trainers have ignored these facts, not recognizing that geometry is more fundamental than arithmetic, and have attempted to make animals arithmeticians when nature has made them geometers. Ourselves accustomed to look on every thing from its numerical aspect, we fail to see how trivial a part this plays in animal life.

There remains the consideration of number, not of objects in space, but of succession in time. This faculty has been claimed for the higher animals. There are many stories of pets keeping up the same action at regular intervals, and always the same number of times per day or per week,—the story of a dog who always wanted three pieces of sugar, of the dog who would always keep out of the way on Sunday, and so on. Mme. Royer explains this as due to ordinary associations without the intervention of abstract